than they can make compensation for by replacing themselves from further removed portions.

The first token of the penetration of oxygen is red-shortness, which, according to Wedding, begins already at O'Ol per cent. 0, whilst with a content of 0*05 per cent, iron will be made in a state of being totally unusable. The phenomenon of red-shortness is not able to be got rid of by the presence of even large amounts of the three reducing agents named ; this can only occur by means of manganese, which, in spite of its not being capable of bringing about complete removal of the oxygen, must nevertheless be regarded as the best destructive agent for the ferrous oxide dissolved in iron. One can, therefore, use manganese also as a preventive agent against red-shortness, by means of large additions thereof to the charge. This takes place nowadays in all cases where metal of the highest quality is to be manufactured. So long as the manganese content remains sufficiently high (about 0*3 per cent, may be regarded as the lowest limit), oxygen cannot be present in the metal in noteworthy quantity. The grounds for this are as follows :—

(a) Manganese has great affinity for iron, and small amounts thereof are retentively held from splitting away. There further takes place a state of equilibrium between the manganese in the metal and the manganese in the slag, and the more the manganese contained in the metal, the quicker this state of equilibrium will be attained. The slag can further only take up a specified maximum content of metallic oxides, and the more manganese oxide contained in it, the less must its content of ferrous oxide become. It is, however, clear that a slag rich in manganese oxide, notwithstanding its possibly very high oxygen content, cannot react so powerfully on the manganese in the charge, as would be the case, if its entire oxygen content were combined with iron. Therefore on the one hand the manganese content of the metal is less diminished, and on the other hand, by exhaustion of ferrous-oxide in the slag, the carbon suffices to reduce manganese-oxide and return it to the metal, in which it is enabled to more energetically attack the traces of ferrous-oxide which have penetrated it than the remaining reducing agents are capable of doing.